CS5401 FS2016 Exam 2 Key

This is a closed-book, closed-notes exam. The only items you are allowed to use are writing implements. Write your name in the designated spot on the top left of each of the exam pages. If you are caught cheating, you will receive a zero grade for this exam. The max number of points per question is indicated in square brackets after each question. The sum of the max points for all the questions is 50. Note that this exam consists of 20 multiple-choice questions followed by a single multi-part open question. You have exactly 75 minutes to complete this exam. Good luck!

Multiple Choice Questions - circle the letter of your choice on the exam pages

1. Genetic drift and natural selection: [2]
   (a) are different terms for the same concept [0] *(false because they are different concepts)*
   (b) are different non-related concepts [$\frac{1}{2}$] *(false because while different, they are certainly related)*
   (c) complement each other because natural selection without genetic drift would select based on phenotypes without regard for genotypes [1] *(bad answer because natural selection selects based on phenotype, whether or not there is genetic drift)*
   (d) complement each other because genetic drift without natural selection would result in random search
2. In Evolution Strategies with uncorrelated mutation with n step sizes, the conceptual motivation for updating the mutation step sizes with the formula $\sigma_i' = \sigma_i \cdot e^{\tau' \cdot N(0,1) + \tau \cdot N_i(0,1)}$ is: [2]
   (a) the sum of two normally distributed variables is also normally distributed [$\frac{1}{2}$]
   (b) the common base mutation $e^{\tau' \cdot N(0,1)}$ allows for an overall change of the mutability, guaranteeing the preservation of all degrees of freedom [1]
   (c) the coordinate-specific $e^{\tau \cdot N_i(0,1)}$ provides the flexibility to use different mutation strategies in different directions [1]
   (d) **all of the above**
   (e) none of the above [0]
3. There is no recombination in "standard" Evolutionary Programming (EP) because: [2]
   (a) extensive research has shown that the use of recombination is counterproductive in EP [0]
   (b) EP was conceived before the invention of recombination [0]
   (c) **each individual in "standard" EP is viewed as the abstraction of a species**
   (d) all of the above [0]
   (e) none of the above [0]
4. The phenomenon of bloat in GP occurs most likely because: [2]
   (a) individuals with bigger genomes have a larger chance of survival (also known as "survival of the fattest") [$\frac{1}{2}$]
   (b) **the variable length aspect of GP causes a natural tendency for the population to reflect the different possible sizes**
   (c) the ratio of alleles to genes in bloated individuals is higher than non-bloated individuals which gives them an evolutionary advantage [0]
   (d) all of the above [$\frac{1}{2}$]
   (e) none of the above [0]

5. Koza states that the aim of the fields of artificial intelligence and machine learning is to generate human-competitive results with a high artificial-to-intelligence (AI) ratio where the AI ratio of a problem-solving method means: [2]

   (a) the ratio of automation (generality) to human intelligence (speciality) needed by the problem-solving method to solve a particular problem [1]

   (b) **the ratio of that which is delivered by the automated operation of the problem-solving method to the amount of intelligence that is supplied by the human applying the method to a particular problem**

   (c) the ratio of artificial intelligence to human intelligence employed by the problem-solving method [1]

   (d) none of the above [0]

6. Koza's Automatically Defined Functions (ADFs) are: [2]

   (a) the application of GP to automate the creation of functions in computer programs [1]

   (b) **the standard method of evolving reusable components in GP**

   (c) the use of GP to create functions with a high AI ratio [$\frac{1}{2}$]

   (d) none of the above [0]

7. The ramped half-and-half method is the most common technique in GP for: [2]

   (a) **initialization**

   (b) parent selection [0]

   (c) survival selection [0]

   (d) termination [0]

   (e) none of the above [0]

8. Learning Classifier Systems are technically speaking: [2]

   (a) a type of Condition-Action Rule-Based System [1]

   (b) a type of Reinforcement Learning System [1]

   (c) a type of Evolutionary Algorithm [0]

   (d) all three types [1]

   (e) **both of the first two types, but not the third**

   (f) none of the above [0]

9. The Pitt and Michigan approaches in Learning Classifier Systems differ in that: [2]

   (a) in the Pitt approach each individual has the option of either representing a single rule or a rule set, while in the Michigan approach each individual represents a single rule and the entire population represents the complete rule set [1]

   (b) in the Pitt approach each individual represents a single rule and the entire population represents the complete rule set, while in the Michigan approach each individual has the option of either representing a single rule or a rule set [$\frac{1}{2}$]

   (c) **in the Pitt approach each individual represents a complete rule set, while in the Michigan approach each individual represents a single rule and the entire population represents the complete rule set**

   (d) in the Pitt approach each individual represents a single rule and the entire population represents the complete rule set, while in the Michigan approach each individual represents a complete rule set [1]

   (e) in the Pitt approach each individual represents a complete rule set, while in the Michigan approach each individual has the option of either representing a single rule or a rule set [1]

   (f) none of the above [0]

10. Speciation is: [2]
    (a) **when geographically separated sub-populations of a species adapt to their local environmental niches to the extent that they become mating-incompatible**
    (b) when sub-populations of different species in the same local environmental niche adapt homogeneously to the extent that they become mating-compatible [0]
    (c) all of the above [0]
    (d) none of the above [0]
11. In Diffusion Model EAs: [2]
    (a) individuals are modeled by diffusion equations and only panmictic mating is permitted [0]
    (b) **the population is conceptually distributed on a grid and mating is restricted to demes**
    (c) all of the above [$\frac{1}{2}$]
    (d) none of the above [0]
12. In Fitness Sharing: [2]
    (a) new individuals replace similar population members, resulting in the population sharing the niches equally [0]
    (b) **the fitness of individuals immediately prior to selection is adjusted according to the number of individuals falling within some prespecified distance of each other**
    (c) individuals share the fitness of similar population members immediately prior to selection, resulting in the number of individuals per niche being dependent on the niche fitness [1]
    (d) none of the above [0]
13. In Multi-Objective problems a solution x is said to be dominated by a solution y when: [2]
    (a) solution x is no better than y in all objectives [1]
    (b) solution x is strictly worse than y in no more than one objective [$\frac{1}{2}$]
    (c) only if both the above are true [1]
    (d) **none of the above**
14. In Multi-Objective EAs employing levels of non-domination, a decrease in the number of levels, generally will: [2]
    (a) not impact the amount of selective pressure [0]
    (b) increase the amount of selective pressure [0]
    (c) **decrease the amount of selective pressure**
    (d) either increase or decrease the amount of selective pressure, depending on the number of conflicting objectives [0]
15. Dawkin's concept of a "meme" is: [2]
    (a) the addition of a learning phase to the evolutionary cycle [$\frac{1}{2}$]
    (b) a unit of biological transmission [$\frac{1}{2}$]
    (c) **a unit of cultural transmission**
    (d) a process of imitation [$\frac{1}{2}$]
    (e) all of the above [$\frac{1}{2}$]
    (f) none of the above [0]

16. In an EA employing Lamarckian evolution: [2]
    (a) improved EA performance is obtained through local search [1]
    (b) **acquired traits are passed on genetically**
    (c) improved EA performance is obtained through the Baldwin effect [0]
    (d) all of the above [$\frac{1}{2}$]
    (e) none of the above [0]

17. Alice is writing an EA to solve the binary knapsack constraint satisfaction problem. The sum of the item costs is 37 while the total cost is constrained to be below 36. Should she: [2]
    (a) Ignore the constraints under the motto: all is well that ends well. [0]
    (b) **Upon generating an infeasible solution, immediately kill it and generate a new solution; repeat this step until a feasible solution is generated.**
    (c) Employ a penalty function that reduces the fitness of infeasible solutions, preferably so that the fitness is reduced in proportion to the number of constraints violated, or to the distance from the feasible region. [$\frac{1}{2}$]
    (d) Employ a repair function that takes infeasible solutions and "repairs" them by transforming them into a related feasible solution, typically as close as possible to the infeasible one. [$1\frac{1}{2}$]
    (e) Employ a closed feasible solution space which guarantees that the initial population consists of feasible solutions only and all evolutionary operations on feasible solutions are guaranteed to result in feasible solutions. Typically a combination of custom representation, initialization, recombination, and mutation is employed to achieve this. [$\frac{1}{2}$]
    (f) Employ a decoder function that maps genotype space to phenotype space such that the phenotypes are guaranteed to be feasible even when the genotypes are infeasible. Typically this involves mapping multiple different genotypes to the same phenotype. [1]

18. A Coevolutionary Algorithm (CoEA) is an EA: [2]
    (a) where the fitness of each individual depends on one or more individuals from a different species [1]
    (b) with exactly two populations [0]
    (c) with two or more populations [0]
    (d) **where the fitness of each individual depends on one or more other individuals**
    (e) none of the above [0]

19. A Competitive Coevolutionary Algorithm is a CoEA: [2]
    (a) with two or more competing populations [$\frac{1}{2}$]
    (b) where each individual competes with one or more individuals in the competing population [1]
    (c) **where individuals compete with each other to gain fitness at each others expense**
    (d) all of the above [1]
    (e) none of the above [0]

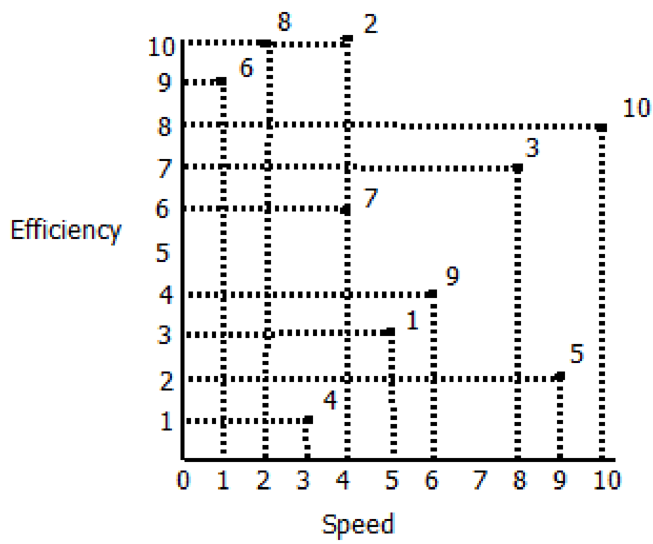
20. Disengagement in a two-population competitive CoEA occurs when: [2]
    (a) the individuals in both populations stop competing and start collaborating [0]
    (b) both populations get stuck in local optimums leading to a loss of search gradient [0]
    (c) one population gets stuck in a local optimum and the other population stops evolving because of a loss of evolutionary pressure [1]
    (d) all of the above [0]
    (e) **none of the above**

Regular Questions - write your answer under the question on the exam page

21. Say you want to minimize the amount of wall time spent running MiniSAT, while simultaneously minimizing its memory usage. You execute a multi-objective EA and the final population contains the solutions listed in the following table, where higher speed indicates less wall time expended, and higher efficiency indicates lower memory utlization:

ID	Speed	Efficiency
1	5	3
2	4	10
3	8	7
4	3	1
5	9	2
6	1	9
7	4	6
8	2	10
9	6	4
10	10	8

(a) Plot the above table and use dotted lines to indicate the area of domination for each element. [2]



(b) List for each element which elements it dominates; indicate elements with their IDs. [2]

ID	Dominates
1	4
2	4,6,7,8
3	1,4,7,9
4	None
5	4
6	None
7	4
8	6
9	1,4
10	1,3,4,5,7,9

(c) Show the population distributed over non-dominated levels like some multi-objective EAs employ, after each addition of an element, starting with element 1 and ending with element 10 increasing the element number one at a time; indicate elements with their IDs. So you need to show ten different population distributions, the first one consisting of a single element, and the last one consisting of ten elements. [6]

After adding element 1:
  Level 1: 1
After adding element 2:
  Level 1: 1,2
After adding element 3:
  Level 1: 2,3
  Level 2: 1
After adding element 4:
  Level 1: 2,3
  Level 2: 1
  Level 3: 4
After adding element 5:
  Level 1: 2,3,5
  Level 2: 1
  Level 3: 4
After adding element 6:
  Level 1: 2,3,5
  Level 2: 1,6
  Level 3: 4
After adding element 7:
  Level 1: 2,3,5
  Level 2: 1,6,7
  Level 3: 4
After adding element 8:
  Level 1: 2,3,5
  Level 2: 1,7,8
  Level 3: 4,6
After adding element 9:
  Level 1: 2,3,5
  Level 2: 7,8,9
  Level 3: 1,6
  Level 4: 4
After adding element 10:
  Level 1: 2,10
  Level 2: 3,5,8
  Level 3: 6,7,9
  Level 4: 1
  Level 5: 4